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Assistive Technology as a Predictor of Social Cohesion among Secondary School Students with Hearing Impairment: A Quantitative Study from Punjab, Pakistan

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Abstract

Assistive technology (AT) is an important part of the solution to diminish communication barriers, which are essential to enhancing social participation for a student who has a hearing loss. As for secondary school, students who are hearing impaired (HI) may experience a variety of challenges in communication, peer interaction, group participation, acceptance and a sense of belonging in the classroom setting. These issues can impact their integration into the school community. In this study, the present practices of AT use among the HI students were examined, their social cohesion level was evaluated, weaker social cohesion aspects were identified, the reasons for the weaker social cohesion related to AT were explored, the relationship between AT use and social cohesion was evaluated and the impact of AT on social cohesion was investigated. The quantitative research method was employed and the survey design of descriptive research was adopted. The subjects were secondary school students with HI attending a school for hearing impaired students in Punjab, Pakistan. Data reported in this study is based on responses selected using cluster sampling from the province of Punjab, Pakistan using two five point Likert scales namely; assistive technology usage related scale and social cohesion measurement scale. The assistive technology scale included sections about AT availability, classroom integration, teacher facilitation, student confidence and barriers. Social cohesion scale included sub sections related peer communication, participation in class, acceptance, belongingness, social support, confidence in interaction, and equal treatment. The data were analysed using descriptive statistics, reliability analysis, Pearson correlation, independent sample t-test, one way ANOVA and simple linear regression using SPSS software. Overall, it was found that the use of AT and social cohesion was high among HI students. The correlation between use of assistive technology and social cohesion was strong, positive and statistically significant. The results of the regression analysis pointed out that the use of assistive technology was a significant predictor of social cohesion. The study suggests that effective availability, regular use, teacher support, assistive technology technical facilitation and student's confidence in AT can make communication more accessible for students with hearing impairments, improve peer interaction, participation, inclusion and belongingness.

Keywords: Assistive Technology, Social Cohesion, Hearing Impairment, Secondary School Students, Special Education, Peer Interaction, Inclusion

Introduction and Background of the Study

For students with hearing impairment, access to curriculum content is not sufficient; they need access to effective communication as well. Hearing impaired pupils can experience background noise, reverberation, distance from the teacher and the rapid rate of classroom communication in most classroom settings, including mainstream and inclusive classrooms. These situations may diminish opportunities for verbal instruction and peer communication. In this context, assistive technology has become an important tool for education and communication support, as it can help to enhance communication, facilitate education in the classroom and improve the use of auditory and visual information. Current evidence indicates that assistive technology can positively impact the educational experiences of learners with hearing impairment; and remote microphone technologies can be especially helpful in classrooms that present listening challenges due to poor acoustics (Bell & Foiret, 2020; Schafer et al., 2020). Academic access does not equal meaningful inclusion. Secondary school students with a hearing impairment also need social cohesion for successful schooling. Peer connectedness, communication participation, mutual acceptance, classroom participation, and a sense of belonging to the school community are aspects of social cohesion. Studies have shown that deaf and hard-of-hearing students may experience some challenges in communicating with their hearing peers, starting communication, participating in-group discussions, and maintaining social relations within inclusive classrooms. Additionally, adolescents with hearing impairment might have more peer-related issues and poorer friendships than their peers with normal hearing. The results indicate that social issues in school are a significant factor to consider when addressing the education of a HI, particularly in the adolescent years when the need for peers is crucial to identity, adjustment and participation in school (Terlektsi et al., 2020; Xie et al., 2014). Children with hearing loss tend to have very poor communication skills in learning and social environments. These challenges can affect a child's ability to speak, participate in the classroom, interact with peers, routine and schoolwork. Students may not participate as well as they could in class activities, due to lack of access to auditory information, noisy class, or inability to follow fast verbal communication. Therefore, early intervention, hearing support, speech therapy, and appropriate communication support are important for enhancing the learning and social experiences for students with hearing impairment (Agyire-Tettey et al., 2017; Dalton, 2011). Assistive technology provides a significant solution to these issues by helping to access learning materials, classroom communication and inclusive participation. Assistive technology to support students with hearing loss may involve such things as hearing aids, cochlear implants, FM systems, remote microphone systems, captioning systems, speech-to-text systems, visual learning systems, digital sign language systems and mobile communication apps. These instruments help to enhance the perception of sound, to listen to information (Boerrigter et al., 2023; Hoogerwerf et al., 2021) and to interact with teachers and peers through listening and/or text (Miura & Yabu, 2023). Teachers also play a key role in effective use of AT. Inclusion is not the responsibility of the devices alone, rather it requires teacher knowledge in how devices can contribute to instruction, classroom communication, and social interactions. Teachers ensure access to learning opportunities, promote student use of devices, adapt the instructional approach, and provide classroom conditions that allow for confident participation of hearing-impaired students. Thus, it is crucial to know the relationship between AT, teacher support and social participation in the development of inclusive educational environment (Farooq & Iftikhar, 2015; Rehman et al., 2024). Efforts have been made in Pakistan too to facilitate communication for deaf and hearing-impaired people using technology. Digital tools and Web-based applications have been created to enable communication in Pakistani Sign Language. There are examples of such programs that demonstrate technology's role in communication access. But the education system for hearing-impaired students has still not overcome challenges including insufficient resources,

inadequate institutional readiness, inadequate teacher training, inadequate support system and non-availability of a consistent communication facility in the education system in Pakistan. These problems have a significant impact on the academic and social development of hearing-impaired students and necessitate continued research on assistive technology and social cohesion especially in the context of hearing-impaired students (Abdallah et al., 2016; Ashraf et al., 2023).

The movement toward inclusive education has increased the presence of students with hearing impairment in regular and secondary school settings. However, physical placement in school does not automatically mean communicative and social inclusion. Students with hearing impairment may be present in the classroom but still struggle to follow fast conversations, peer discussion, and informal communication. Xie, Potmesil and Peters (2014) reported that deaf and hard-of-hearing children often face difficulty in communicating with hearing peers and in initiating, joining, and sustaining interactions in inclusive schools. Similarly, Rekkedal (2017) observed that participation of students with hearing loss is influenced by personal and environmental factors. These findings indicate that the issue is not only school placement but also meaningful participation in school life. School social cohesion is the level of engagement of students in school and classroom activities, of their positive relationships with other students, of their feeling of being welcomed and accepted, and of their involvement in the social life of the school and classroom. Social cohesion is related to access to communication for students with hearing impairment. In a longitudinal study of deaf and hard-of-hearing students, in general education classrooms over a five-year period, Antia et al. (2011) found that key classroom communication participation and extracurricular involvement factors were good predictors of social outcomes. This is especially significant for secondary level where friendship, peer acceptance and cooperative learning take a prominent role in social development. The purpose of assistive technology is to decrease communication barriers and to enhance participation. Hearing aids, cochlear implant support systems, remote microphone/FM systems, captioning systems, speech-to-text applications and assistive listening systems may enhance access to teachers' speech, classroom discussion and environmental communication cues. Schafer et al. (2020) demonstrated that classrooms can be noisy and reverberant and that the use of remote microphone technology is beneficial for the hearing impairment and other auditory needs of children. Bell and Foiret (2020) also found that the use of assistive technology is beneficial to the educational success of students with hearing disabilities.

Statement of the Problem

The problem of communication continues to have an impact on learning, social development and school adjustment for students with hearing loss. Peer communication, cooperation and social identity formation are particularly significant at the secondary level. Students who have hearing loss may feel isolated from the classroom, lack confidence and engagement in classroom discussions, and lack engagement in interpersonal communication. While assistive technology (such as hearing aids, cochlear implants, FM systems, captioning and digital communication apps) can help to lower communication barriers, low access, teacher training, technical support and awareness may contribute to inconsistent access in the classroom. Despite the growing use of assistive technology in educational institutions, there remains a major research gap regarding how such technology contributes to social cohesion at the secondary school level. Previous research shows that deaf learners in mainstream and secondary school contexts may still experience problems of belonging, participation, and peer relationship quality even when they are physically included in school. Prior (2023) emphasized that deaf learners' educational experiences are closely connected with whether they feel heard, understood, and meaningfully included, while Wolters (2013) showed that social participation, acceptance, and popularity are central aspects of school

life among deaf adolescents. In Pakistan, evidence suggests that digital technology can support social inclusion of hearing-impaired students, but empirical research directly linking assistive technology with social cohesion among secondary school students with hearing impairment remains limited. Assistive technology is often discussed as an academic support mechanism, but its social role is equally important. Devices and communication supports can improve access to classroom instruction; however, better access to instruction does not automatically guarantee stronger peer interaction, acceptance, shared participation, or belonging. Therefore, it was necessary to investigate whether assistive technology supports the social life of hearing-impaired students beyond its instructional value.

Research Objectives

The objectives of the study were:

1. To search out assistive technology forms used by hearing-impaired students.
2. To search out the present practices of using assistive technology in school and daily life by hearing-impaired students and their teachers.
3. To evaluate social cohesion among hearing-impaired students.
4. To search out weaker areas in social cohesion among hearing-impaired students.
5. To find out the reasons behind weaker social cohesion among hearing-impaired students related to assistive technology.
6. To evaluate the relationship between the use of assistive technology and the social cohesion development of students with hearing impairment in the secondary classes.
7. To investigate the impact of assistive technology on social cohesion among hearing-impaired students.

Research Questions

1. What forms of assistive technology are used by hearing-impaired students?
2. What are the present practices of using assistive technology in school and daily life by hearing-impaired students and their teachers?
3. What is the level of social cohesion among hearing-impaired students?
4. What are the weaker areas in social cohesion among hearing-impaired students?
5. What are the reasons behind weaker social cohesion among hearing-impaired students related to assistive technology?
6. What is the relationship between the use of assistive technology and the social cohesion development of students with hearing impairment in secondary classes?
7. What is the impact of assistive technology on social cohesion among hearing-impaired students at the secondary school level?

Hypotheses of the Study

The following null hypotheses were tested:

H01: There is no significant relationship between assistive technology usage and social cohesion among secondary school students with hearing impairment.

H02: Assistive technology usage has no significant impact on social cohesion among secondary school students with hearing impairment.

H03: There is no significant difference in social cohesion among secondary school students with hearing impairment based on gender.

H04: There is no significant difference in social cohesion among secondary school students with hearing impairment based on class level.

H05: There is no significant difference in social cohesion among secondary school students with hearing impairment based on access to assistive technology at home.
H06: There is no significant difference in social cohesion among secondary school students with hearing impairment across age groups.
H07: There is no significant difference in social cohesion among secondary school students with hearing impairment across levels of hearing impairment.
H08: There is no significant difference in social cohesion among secondary school students with hearing impairment across years of assistive technology use.

Significance of the Study

The study is valuable for special education due to its emphasis on social role of assistive technology. Although academic access and learning support are important aspects of AT, this study takes a different approach by examining how AT can impact peer interaction, communication, participation in the classroom, perception of acceptance, and sense of belonging for the hearing-impaired student. This study is important for students with hearing impairments, as it highlights the role of assistive technology in enhancing communication and social engagement. The findings can assist schools to recognize that hearing-impaired students need devices as well as appropriate training, technical assistance, teacher instruction, and classroom accommodations. This study is important for teachers as it emphasizes their role in the effective use of AT. Teachers to integrate technology in the teaching process, encourage students with the use of assistive devices, utilize visual aids, provide digital resources, and provide opportunities for interaction. It is important for school heads and administrators to be aware of the practical barriers that may affect the effectiveness of AT such as the lack of training, technical difficulties, maintenance problems, and limited classroom time. Based on these findings, school administration can enhance the technical support and teacher training. The study is important for both the policymakers and the Special Education Department as it gives evidence of AT use and social cohesion at secondary level of Education in Punjab. The results can contribute to planning teacher training, enhancing technology provision and inclusive education policies.

Literature Review

Hearing Impairment

The degree of hearing loss is one of the most commonly agreed systems of classifying hearing impairment in terms of decibels. This division includes mild, moderate, severe, and profound hearing loss. Mild and moderate hearing loss might enable people to hear certain sounds of speech with some difficulty, whereas severe and profound hearing loss greatly limits sound. This category is useful during educational planning because the learning needs of pupils can be established in terms of the type and level of support and assistive technology required (Basura et al., 2023). Educationally, hearing impairment is often regarded as either deaf or hard of hearing depending on the functional communication skills. Deaf persons usually use more visual means of communication like sign language, whereas those whose hearing is not fully developed apply residual hearing with the help of amplification devices (Qi & Mitchell, 2021). Acquired hearing loss sets in after birth and may take place at any point of life. The usual causes are childhood diseases like meningitis, measles, and chronic ear infections. In most developing nations, the absence of timely medical care predisposes patients to irreversible hearing loss, which impacts the learning of students as well as their social involvement in later stages (Olusanya, Neumann, & Saunders, 2014). Ototoxicity is another important cause of hearing loss, resulting from drugs that destroy the hearing system. Aminoglycoside antibiotics and chemotherapy agents adversely affect

hearing. Students with ototoxic hearing loss may develop sudden or progressive acute auditory performance issues, affecting communicative abilities in the classroom (Rybak & Ramkumar, 2007). The severity or degree of hearing loss is one of the key determinants of academic success because it identifies the capability of students in using spoken language, classroom-based learning, and interaction with other students. Research has indicated that children with mild or severe hearing impairment tend to show poor language development compared to their hearing counterparts, and the gap usually varies with the degree of hearing impairment. Educational stresses are not limited to extreme or deep cases; even somewhat impaired hearing can reduce the ability to gain access to verbal education and classroom communication, adversely affecting vocabulary growth, literacy skills, and learning involvement (Tomblin et al., 2015; LeClair & Saunders, 2019). Students with mild, moderate, and unilateral hearing loss can be exposed to significant educational risks since their challenges are not always taken seriously in educational institutions. A systematic review by Zussino et al. (2022) revealed that children with mild and moderate hearing impairment performed worse than hearing control children in speech production, receptive and expressive morphology, following directions, sentence recalling, and reading words and non-words. Lieu (2004) stated that speech-language and education problems were also caused by unilateral hearing loss, disputing the assumption that one ear with normal hearing was sufficient to ensure normal academic development. Hearing impaired students face various learning difficulties and these difficulties have a major impact on their learning achievement and learning experiences. Some of the most salient threats are the absence of spoken instructional resources in traditional classes where most instruction takes place orally. This limitation is limiting students' capacity to follow lectures, seek explanations and participate in class activities, especially at secondary school where the curriculum is becoming very complex (World Health Organization, 2021). One of the most important educational problems is the language development problem, because language development delays are caused by auditory deprivation which occurred in the children's early childhood which leads to their vocabulary, grammar, and reading comprehension problems (Marschark & Hauser, 2012).

Assistive Technology

Assistive technology can be used to help students with a hearing loss access learning, and it can also be used to improve social interaction and engagement. The use of hearing technologies such as hearing aids, cochlear implants, remote microphone systems and captioning can help learners to communicate with teachers and peers more effectively, reduce misunderstandings, and enhance social confidence. These tools are linked to academic success and the development of social skills and emotional health within the school environment (Millett & Mulla, 2025). The social approach to disability recognizes disability as an outcome of environmental constraints and is supportive to AT. By providing appropriate technology, structural barriers can be minimised, giving equal opportunities to include students with a hearing loss (Oliver, 2017). Hearing aids are created to give the person greater access to sound in all settings. They come in two categories: single hearing aids and group hearing aids. Group hearing aids are utilized to assist students with similar degrees of hearing loss. The machine is mounted on a table in a horseshoe shape with student switches to manipulate. The pupil puts on headphones and turns on the aid. A teacher uses a microphone when teaching, amplifying the sound so every student in the classroom gets information. The teacher can also respond to individual students using their microphones (Hallahan & Kauffman, 2010). Cochlear implants are more complicated electronic rehabilitative devices applied to those with severe to profound sensorineural hearing impairment when conventional hearing aids cannot assist significantly. Cochlear implants do not provide amplification of incoming sound but rather bypass damaged hair cells in the cochlea and provide direct stimulus to the auditory nerve via an electrical

array of implanted electrodes. According to recent literature, they are highly successful neural prostheses that have enabled the hearing rehabilitation field to become more effective by enabling users to process sound and providing the capability to communicate, develop language, and engage socially (Podury et al., 2025). Long-term outcome studies in children and adolescents demonstrate the value of cochlear implants. Children with cochlear implants performed better in reading and writing and had better quality of life than those with comparable severe hearing loss who were not implanted (Cejas et al., 2023). Classroom FM systems are amplifier listening aids that help a student have better auditory capacity of the teacher in a loud and reverberant classroom setting. The student carries receivers or ear-level apparatus, the teacher carries a transmitter, and microphone, delivering speech signals nearer to the student. This arrangement improves the signal-to-noise ratio and constrains the negative effects of distance, background noise, and poor classroom acoustics. FM systems are generally considered important educational tools for children with hearing impairments or auditory processing disabilities (Bigras et al., 2024; Stavrinos et al., 2020). Real-time captioning systems like Communication Access Real-time Translation (CART) are significant in providing support to students with hearing impairments in lectures, discussions, and multimedia presentations. CART enables students to trace complicated explanations and classroom dialogues through real-time conversion of spoken language into text. Real-time captioning devices bring heightened interaction and decrease dependence on classmates or instructors to clarify spoken information repeatedly (Marschark et al., 2006). Research indicates that mobile communication technologies and assistive applications play an important role in learning and engagement by students with hearing impairments, particularly in secondary schools where digital access and interactivity are important (Alit et al., 2025).

Social Cohesion

The level of connectedness, trust, and solidarity of a member in a group or society is commonly known as social cohesion. Social cohesion in learning institutions encompasses the degree to which students feel acceptable, appreciated, and belonging to the school community. Positive peer relationships, cooperation, and belonging among students are promoted in a cohesive learning environment. For students with hearing impairment, social cohesion is specifically significant since they, due to communication barriers, may be less involved in social interactions and classroom activities, affecting their relations with peers and overall school life (Schiefer & van der Noll, 2017; Koster et al., 2010). Social cohesion is a multidimensional concept integrating social inclusion, participation, shared values, trust, and mutual respect between individuals in a community. In school, these dimensions are manifested in how students associate with other students and teachers, their academic and social activities, and their sense of belonging to the school atmosphere (Antia et al., 2002). The physical and organizational environment of educational institutions influences social cohesion not only through social interaction but also through environmental factors. Classroom layout, access, noise control, and availability of support services can greatly influence students' ability to communicate and engage in learning activities. An effective learning environment facilitates communication, cooperation, and engagement among learners, enhancing social affiliations and belongingness to the school community. Environmental factors like low background noise, proper seating arrangement, and facilitating classroom practices are especially relevant to students with hearing impairment (Shield & Dockrell, 2003; Koster et al., 2010). Social cohesion is especially crucial during adolescence, when social, emotional, and psychological changes are extremely important. Youths are trying to establish their social identity, and peer relationships become more significant as a source of emotional support and self-affirmation. An inclusive school setting that supports adolescents is very important in assisting them to acquire positive interpersonal skills, understanding, and a sense

of belonging in their peer groups. Acceptance and positive peer intervention in school positively influence social adjustment and well-being of students (Wentzel & Muenks, 2016; Eccles & Roeser, 2011).

Role of Assistive Technology in Promoting Social Cohesion

Students with hearing impairment require special needs that lead to bad experiences during their school years. Their difficulties are normally limited to the capacity to access all audio information in classrooms, communicate effectively with peers and teachers, and participate actively in classroom activities (Nordlund, 2003). Assistive devices that aim to alleviate these difficulties are critical resources that facilitate inclusiveness in learning environments, increase communication, and enhance access to educational resources. Assistive technology encompasses a number of devices and services that provide support to students with hearing impairment in learning settings, including hearing aids and cochlear implants primarily used to improve auditory perception and support communication between peers and educators (Krijger et al., 2020). To improve hearing loss, assistive technologies such as hearing aids and cochlear implants increase accessibility to sound and help people communicate better. These technologies assist in maintaining and enhancing functions, allowing people to engage more in education, social activity, and life. When hearing-impaired students manage to understand conversation and become more active and fully engaged in interactions with others, communication skills are enhanced, and students are better able to sense acceptance by peers, contributing to belonging and inclusion in schools (World Health Organization & UNICEF, 2022). Inclusive classrooms that accommodate hearing-impaired students serve not only as an enhancement to access to instruction but also play a major role in social engagement and acceptance among peers. Students with cochlear implants and other hearing aids display higher levels of social interactions, communication, and emotional stability when learning environments foster effective communication between hearing and deaf students (Punch & Hyde, 2011; Xie et al., 2014). Assistive technology can also change the attitudes of peers toward students with hearing impairment. The use of assistive devices can enhance communication and limit barriers between hearing and hearing-impaired students, consequently enhancing more accommodative attitudes among peers. Inclusive application of assistive technology facilitates higher levels of social interaction and positively influences peer perceptions, resulting in more inclusive peer relationships and ultimately leading to social cohesion within the school environment (Bell & Foiret, 2020; Soetan et al., 2021).

Empirical Evidence Linking Assistive Technology and Social Cohesion

Empirical research in developing settings shows that employing assistive technologies can make a significant contribution to the social inclusivity and cohesion of students with hearing disabilities. A study of hearing-impaired adolescents in Pakistan revealed that digital technological aids such as information and communication technologies were linked to increased levels of social inclusion and integration into larger social networks, indicating that supportive technologies could help lessen feelings of isolation and encourage involvement in society (Ashraf et al., 2023). Mixed-method research points out that assistive technology not only improves communication skills but also positively affects peer attitudes and social interactions in inclusive educational environments. Systematic reviews have found that use of assistive technology contributes to increased inclusion and engagement of students with disabilities, associated with enhanced social interactions and fewer feelings of isolation and stigma among peers (Fernandez Batanero et al., 2022; Jimenez Arberas & Diaz, 2021). As of late, more and more research has been completed in Pakistan, with a growing emphasis on the importance of AT in the access to education for people with disabilities. Though inclusive education has been included in the national education policy, research shows

that national education policy intentions are not always reflected in the use of assistive facilities due to the lack of resources, insufficient teacher training, inadequate infrastructure and lack of support systems. Differences also exist between theoretical and practical implementation of AT in local schools with most of the local schools lacking the training and resources for implementing AT in a meaningful way (Perveen et al., 2023; Ashfaq et al., 2024). Although both the hearing aid and the FM system are identified as important assistive listening devices, availability and uptake in secondary schools is low and there is a small impact on academic participation and achievement. However, the devices are not utilized optimally, teachers lack experience in using them and are not provided with maintenance measures, and they are not used to enrich learning (Ashfaq et al., 2025; Mahmood & Anwar, 2025).

Research Gap

Analysis of the national and international literature revealed that the fields of hearing impairment, inclusive education, and assistive technology are well-studied. Most of this literature, however, has been concerned primarily with academic achievement, language development, classroom listening, and access to language instruction. Much less has been done to investigate the social aspect of schooling, which is about the communication with peers, the involvement in the classroom, acceptance by peers, sense of belonging, emotional support, and equal treatment. It is clear that there is a need to explore social cohesion as an important educational goal for students with hearing loss. A second gap is that much of the literature includes discussions of the use of assistive technology as a tool for device or academic support, but less is directly discussed on the use of assistive technology as a tool for social support. While hearing aids, cochlear implants, FM systems, captioning devices, speech-to-text applications, visual learning technologies, and digital communication tools might enhance access to classroom communication, increased access does not necessarily translate into increased peer acceptance, participation in classroom communication, or feeling like a part of it. Thus, it is important to explore if the use of assistive technology can enhance social cohesion amongst secondary school learners with hearing loss. There is also a gap in the context of Pakistan. While the recent research in Pakistan has touched on inclusive education, digital technologies and the problems of using assistive technology, there is little empirical research on how people with hearing loss use assistive technology and how this influences social cohesion at the secondary school level in Punjab. There is limited research available on the relationship of assistive technology use with social cohesion of secondary school students with hearing impairment (SHI).

Research Methodology

Research Design

The study was of a quantitative descriptive survey type. The design was suitable as it allowed for the researcher to gather answers from a sample group and then analyse those responses statistically. The most common method of gathering data on attitudes, perceptions, practices, opinions and behavioural patterns from a selected population is the survey (Mohajan, 2020). The survey design was appropriate for this study due to its ability to gather information regarding AT use and social cohesion from secondary school students with hearing impairment. The study was descriptive because it aimed at describing the existing forms, practices, levels and challenges of assistive technology use. It was also analytical in that it investigated the potential for a significant relationship and predictability of the use of AT with social cohesion. The study did not include an experiment, so the results are a statistical association and prediction, not an experiment with cause and effect.

Population and Sampling

The respondents were secondary school students with hearing impairment of Punjab, Pakistan. The province of Punjab was chosen as a delimiting study. All secondary school students with hearing impairment enrolled in selected special education institutions or schools serving students with hearing impairment in Punjab were considered the target population. A cluster random sampling technique was used. In the first phase schools were segmented region wise, i.e. North Punjab schools, Central Punjab schools and South Punjab schools. A second stage was conducted by a random sampling of schools from all the regional clusters, with a balance of boys and girls. In the third stage, the students with hearing Loss were picked from the selected schools. A total of 308 questionnaires were sent out. Of these 250 responses were valid and used for SPSS entry. Of the remaining 58 responses, were not included in this report. The number of samples utilized for descriptive statistics, reliability analysis, Pearson correlation, independent sample t-tests, one-way ANOVA and simple linear regression was 250.

Research Tools

Data collection was done using structured questionnaire-based tools. The questionnaire was developed to assess two key constructs of assistive technology use and social cohesion. The first part assessed the use of assistive technology in terms of items related to availability, classroom use, teacher support, student use and confidence, and barriers/challenges in the use of assistive technology. Assistive technology products included cochlear implants, FM systems, hearing aids, visual learning technologies, speech-to-text products, captioned learning products, digital tools, mobile applications, interactive boards, online learning products, visual alert systems, and technical support. The second portion assessed social cohesion, such as peer communication, involvement in classroom activities, acceptance by peers, belongingness, social support, emotional bonding, confidence in communicating, trust and equal treatment in the classroom. The items were all measured on a five-point likert scale.

Validity and Reliability

Expert opinion was used to ensure the validity of the research tools. The items on the questionnaire were piloted by experts in education, special education, and research methodology. They were given the opportunity to make recommendations on ways to improve wording, clarity, and relevance. To explore clarity, readability and implementation of the questionnaire, a pilot test was performed prior to data collection. Pilots tested and corrections and refinements were made. Cronbach's Alpha was used to check the reliability. Cronbach's Alpha values of .520, .355, .048, .368, and .525 were obtained for the overall Assistive Technology Scale, the Assistive Technology Usage Scale, the Assistive Technology Barriers Scale, the Student social cohesion Scale, and the Teacher-rated social cohesion Scale, respectively, in the reliability analysis. The values suggest that the instruments are measuring multiple related but different dimensions, and not one very consistent one. The findings were interpreted with care and substantiated using Item-wise and Factor-wise interpretation.

Data Collection Procedure

The researcher went to each school selected for data collection personally. Permission was obtained from concerned authorities. The study purpose was explained to the school administration, teachers and respondents. Students with a hearing impairment received the questionnaire, with the assistance of teachers when required to understand the items of the questionnaire. The questionnaires were distributed throughout the total number of 308 questionnaires to which 250 valid questionnaires were received for SPSS analysis.

Data Analysis

SPSS was used to analyze data. Demographic data and response patterns were presented in terms of frequency and percentage. To compute the level of assistive technology usage and social cohesion the mean and standard deviation were used. Reliability was determined by using Cronbach's Alpha. Pearson correlation was used in order to analyze relationship. Independent sample t-tests were used for comparing the two-group variables on the social cohesion. Social cohesion was compared between multi-group variables by using one-way ANOVA. Simple linear regression was used to investigate the effect of AT use on social cohesion.

Ethical Considerations

All ethical issues were abided by throughout the study. School authorities' permission was requested. All respondents were told the purpose of the study and participation was voluntary. No data regarding respondents' identity were provided. Data collection, entry, analysis and reporting were kept confidential. Extra care was taken as a special population were the respondents, students with hearing impairment. Clear explanations of instructions and support as necessary.

Results

Demographic Profile of Respondents

Table 1: Demographic Profile of Respondents (N = 250)

Variable	Category	Frequency	Percentage
Class	9th class	137	54.8
	10th class	113	45.2
Gender	Male	140	56.0
	Female	110	44.0
Age Group	12-13	22	8.8
	14-15	94	37.6
	16-17	123	49.2
	18 and above	11	4.4
Level of Hearing Impairment	Mild	31	12.4
	Moderate	71	28.4
	Severe	114	45.6
	Profound	34	13.6
Primary Mode of Communication	Sign Language	20	8.0
	Lip Reading	62	24.8
	Spoken Language	166	66.4
	Total Communication	2	0.8
Hearing Device Type	Hearing Aid	112	44.8
	Cochlear Implant	138	55.2
Years of Assistive Technology Use	Less than 1 year	22	8.8
	1–3 years	55	22.0
	4–6 years	122	48.8
	More than 6 years	51	20.4
Access to Assistive Technology at Home	Yes	199	79.6
	No	51	20.4

Results Related to Research Objective 1: Forms of Assistive Technology Used by Hearing-Impaired Students

Table 2: Forms of Assistive Technology Used by Students

Assistive Technology Type	Mean	SD	Level
Mobile applications and tablets/laptops	3.80	1.21	High
Cochlear implants	3.69	1.28	High
Hearing aids	3.67	1.31	High
Visual learning technologies	3.58	1.35	High
Interactive boards	3.55	1.37	High
Online learning platforms	3.53	1.39	High
Captioned learning materials	3.48	1.38	High
FM systems	3.45	1.36	High
Visual alert systems	3.42	1.34	High
Speech-to-text tools	3.07	1.42	Moderate

The most commonly used assistive technologies were mobile applications and tablets/laptops (M = 3.80), cochlear implants (M = 3.69), and hearing aids (M = 3.67). Speech-to-text tools showed the lowest usage (M = 3.07). Overall, students reported high usage of various forms of assistive technology.

Results Related to Research Objective 2: Present Practices of Using Assistive Technology

Table 3 (a): Present Practices of Assistive Technology Use

Practice Area	Mean	SD	Level
Availability of Assistive Technology	3.57	1.27	High
Use of Assistive Technology by Teachers	3.53	1.32	High
Use of Assistive Technology by Students	3.62	1.26	High
Difficulties in Using Assistive Technology	3.49	1.35	High

Table 3 (b) Key Findings on Practices:

Practice Item	Mean	SD
Teachers regularly use assistive technology in classroom	3.67	1.29
Students use FM/loop systems during group activities	3.87	1.18
Students use devices independently	3.17	1.38
Teachers provide visual aids along with auditory instruction	3.31	1.37
Technical support is available for device maintenance	3.45	1.41

Students reported high levels of assistive technology availability (M = 3.57), teacher use (M = 3.53), and student use (M = 3.62). Students used assistive technology most frequently during group activities (M = 3.87), while independent device use was relatively lower (M = 3.17). The most significant difficulty was limited classroom time for technology use (M = 3.73), followed by difficulty operating devices (M = 3.64).

Results Related to Research Objective 3: Level of Social Cohesion Among Hearing-Impaired Students

Table 4: Overall Level of Social Cohesion

Dimension	Mean	SD	Level
Peer Interaction	3.66	1.27	High
Sense of Belonging	3.51	1.32	High
Participation and Collaboration	3.57	1.27	High
Communication	3.52	1.38	High
Acceptance and Inclusion	3.62	1.23	High
Emotional Connection and Trust	3.66	1.23	High
Social Cohesion in Classroom	3.44	1.37	High
Total	**3.57**	**0.23**	High

The overall social cohesion among hearing-impaired students was at a high level (M = 3.57). The strongest dimensions were Peer Interaction (M = 3.66) and Emotional Connection and Trust (M = 3.66), while Social Cohesion in Classroom was the weakest but still at a high level (M = 3.44).

Results Related to Research Objective 4: Weaker Areas in Social Cohesion

Table 5: Weaker Areas Identified in Social Cohesion

Dimension	Weaker Item	Mean	SD	Interpretation
Peer Interaction	Classmates include HI in discussions	3.56	1.34	
Sense of Belonging	HI students feel accepted by their classmates	3.29	1.38	Weaker
Participation	HI students enjoy working with classmates in projects	3.35	1.31	Weaker
Communication	HI students feel confident asking questions in class	3.10	1.42	Weaker
Acceptance	HI students feel socially supported at school	3.32	1.28	Weaker
Emotional Connection	HI students trust on their classmates	3.42	1.35	
Classroom Cohesion	HI students feel them equal to other students	3.07	1.41	Weaker

According to data, the weakest areas in social cohesion included; Feeling equal to other students (M = 3.07), lack of cconfidence in asking questions in class (M = 3.10), feeling less accepted by classmates (M = 3.29), ffeeling less socially supported at school (M = 3.32) and less enjoying collaborative work (M = 3.35).

Results Related to Research Objective 5: Reasons Behind Weaker Social Cohesion Related to Assistive Technology

Table 6: Reasons for Weaker Social Cohesion Linked to Assistive Technology Barriers

Assistive Technology Barrier	Mean	Related Weaker Social Cohesion Area	Interpretation
Limited time for technology use in class	3.73	Collaborative learning, social participation	Reduced opportunities for peer interaction and group work

Difficulty operating devices	3.64	Peer interaction, classroom participation	Students hesitate to communicate and participate less
Need for help to use devices	3.56	Independence, self-confidence	Dependence on others reduces confident social interaction
Unclear instructions for use	3.55	Independent participation	Incorrect device use leads to reduced participation
Maintenance problems	3.53	Regular use, reliability	Inconsistent use reduces communication support
Technical issues during use	3.47	Group work, classroom communication	Disturbed communication reduces involvement
Lack of proper training	3.46	Confidence, participation	Reduced effective use and increased dependency
Teachers' challenges with AT	3.35	Teacher-student communication, inclusion	Students may not receive proper communication support
Signal/connectivity issues	3.13	Communication, peer response	Missed instructions weaken interaction

The strongest reasons for weaker social cohesion related to assistive technology were: limited classroom time for technology use (M = 3.73), difficulty operating devices (M = 3.64), need for help (M = 3.56), and unclear instructions (M = 3.55). These barriers affected peer interaction, participation, communication, and confidence.

Results Related to Research Objective 6: Relationship Between Assistive Technology Use and Social Cohesion

Hypothesis H01: There is no significant relationship between assistive technology usage and social cohesion among secondary school students with hearing impairment.

Table 7: Pearson Correlation Between Assistive Technology and Social Cohesion

Variable 1	Variable 2	N	Pearson r	p-value	Decision
Assistive Technology Usage	Student Social Cohesion	250	.805	.000	Significant
Assistive Technology Usage	Teacher-rated Social Cohesion	250	.838	.000	Significant
Assistive Technology Barriers	Student Social Cohesion	250	.628	.000	Significant
Assistive Technology Barriers	Teacher-rated Social Cohesion	250	.705	.000	Significant

The correlation analysis revealed a strong, positive, and statistically significant relationship between assistive technology usage and student social cohesion ($r = .805$, $p < .001$). Therefore, H01 was rejected. The use of assistive technology is significantly associated with higher social cohesion among secondary school students with hearing impairment.

Results Related to Research Objective 7: Impact of Assistive Technology on Social Cohesion

Hypothesis H02: Assistive technology usage has no significant impact on social cohesion among secondary school students with hearing impairment.

Table 8: Regression Analysis Summary

Model	R	R Square	Adjusted R Square	Standard Error
1	.805	.648	.646	.13

ANOVA Results:

Source	Sum of Squares	df	Mean Square	F	p-value
Regression	9.94	1	9.94	523.45	.000
Residual	4.72	248	.019		
Total	14.66	249			

Coefficients:

Predictor	B	SE	β	t	p-value
Constant	1.02	.12	--	8.92	.000
Assistive Technology Usage	.70	.03	.805	22.87	.000

The regression model was statistically significant ($F = 523.45$, $p < .001$). Assistive technology usage explained 64.8% of the variance in social cohesion ($R^2 = .648$). The standardized beta coefficient ($\beta = .805$, $p < .001$) indicates that assistive technology usage is a significant predictor of social cohesion. Therefore, H02 is rejected.

Results Related to Hypotheses H03-H08: Group Differences in Social Cohesion

Table 9: Group Differences in Student Social Cohesion

Hypothesis	Variable	Test	Result	p-value	Decision
H03	Gender	Independent t-test	t(248) = -0.89	.374	Retained
H04	Class Level	Independent t-test	t(248) = 0.18	.857	Retained
H05	Home Access to AT	Independent t-test	t(248) = 1.78	.075	Retained
H06	Age Group	One-way ANOVA	F(3, 246) = 2.67	.047	Rejected
H07	Hearing Impairment Level	One-way ANOVA	F(3, 246) = 6.83	.000	Rejected
H08	Years of AT Use	One-way ANOVA	F(3, 246) = 3.85	.010	Rejected

H03 Retained: There is no significant difference in social cohesion based on gender.
H04 Retained: There is no significant difference in social cohesion based on class level.
H05 Retained: There is no significant difference in social cohesion based on home access to assistive technology.
H06 Rejected: There is a significant difference in social cohesion across age groups ($p = .047$).
H07 Rejected: There is a significant difference in social cohesion across levels of hearing impairment ($p = .000$).

H08 Rejected: There is a significant difference in social cohesion across years of assistive technology use (p = .010).

Summary of Hypothesis Testing

Table 10: Comprehensive Summary of Hypothesis Testing

Hypothesis	Statement	Statistical Test	Result	Decision
H01	No significant relationship between AT usage and social cohesion	Pearson Correlation	r = .805, p = .000	**Rejected**
H02	AT usage has no significant impact on social cohesion	Simple Linear Regression	β = .805, p = .000	**Rejected**
H03	No significant difference in social cohesion based on gender	Independent t-test	p = .374	**Retained**
H04	No significant difference in social cohesion based on class level	Independent t-test	p = .857	**Retained**
H05	No significant difference in social cohesion based on home AT access	Independent t-test	p = .075	**Retained**
H06	No significant difference in social cohesion across age groups	One-way ANOVA	p = .047	**Rejected**
H07	No significant difference in social cohesion across hearing impairment levels	One-way ANOVA	p = .000	**Rejected**
H08	No significant difference in social cohesion across years of AT use	One-way ANOVA	p = .010	**Rejected**

Table 11 Summary of Key Findings Aligned with Research Objectives

Objective		Finding
1	Forms of AT used	Mobile apps/tablets (M=3.80), cochlear implants (M=3.69), hearing aids (M=3.67) were most common; speech-to-text (M=3.07) was least common
2	Present practices of AT use	High availability (M=3.57), teacher use (M=3.53), student use (M=3.62); limited classroom time (M=3.73) was the main barrier
3	Level of social cohesion	Overall high level (M=3.57); peer interaction (M=3.66) and emotional connection (M=3.66) were strongest
4	Weaker areas in social cohesion	Feeling equal (M=3.07), confidence asking questions (M=3.10), acceptance (M=3.29) were weakest

5	Reasons for weaker cohesion	Limited time (M=3.73), device operation difficulty (M=3.64), need for help (M=3.56), unclear instructions (M=3.55)
6	Relationship between AT and cohesion	Strong positive correlation ($r = .805$, $p < .001$); significant relationship confirmed
7	Impact of AT on cohesion	Significant predictor ($\beta = .805$, $p < .001$); explains 64.8% of variance in social cohesion

Discussion

This study aimed to analyse the role of assistive technology in social integration of secondary school hearing impaired students in Punjab, Pakistan. The results showed fairly high levels of assistive technology use in terms of availability, type of AT, teacher use, and student use. Students reported experiencing the use of hearing support devices, digital tools, visual learning technologies, mobile applications, interactive boards, and assistive listening systems in the classroom and routine environments.

Socio-emotional factors of students with hearing impairment, such as peer interaction, sense of belonging, participation, communication, acceptance, emotional connection and classroom cohesion, were also overall positive. There were some weaker areas identified, however, including the feeling of being accepted by classmates, enjoying collaborative work, confidence in asking questions, feeling socially supported, feeling that classmates are trustworthy, and feeling equal to classmates. Results of the correlation analysis showed significant and positive correlation between the use of assistive technology and social cohesion ($r = .805$, $p < .001$).

The results of regression analysis showed that the use of assistive technology could significantly predict social cohesion ($\beta = .805$, $p < .001$) with 64.8% variance. There was a significant difference in age, level of hearing impairment, and years using assistive technology between the groups, but not for gender, class, home access, communication mode, or device type.

The results indicate that assistive technology is important to the social integration of the hearing impaired students. High mean scores for both availability and teacher and student use indicate that students can generally access AT within school and in their lives. This is consistent with research internationally which indicates that use of assistive technologies like hearing aids, cochlear implants, FM systems and captioning devices can enhance speech perception, listening comprehension and classroom participation (Marschark et al., 2015; Schafer et al., 2020). But the results show that this is not enough. The percentage of difficulties reported is high, suggesting that there are practical challenges for students and teachers in the adoption of AT. Barriers include the lack of training, the technical issues, the instructions are confusing, maintenance is difficult, the operation of the device causes problems, signal issues, and not enough time in the classroom. The results align with the national studies conducted in Pakistan that identified various challenges for the implementation, including poor training, inconsistent use, and lack of institutional support (Ashfaq et al., 2024; Mahmood & Anwar, 2025).

The positive social cohesion scores show that a lot of the hearing-impaired students were socially active and connected in the school context. The finding is consistent with the argument that inclusive education practices with appropriate support can enable social participation (Xie et al., 2014; Antia et al., 2011). However, the weaker areas identified, especially feeling equal to other students ($M = 3.07$) and confidence in asking questions ($M = 3.10$) indicates that social cohesion is not fully realised. These weaker points are important because they encompass aspects of social inclusion beyond being physically present in the classroom. Academic involvement without social inclusion.

Especially important is the one between assistive technology barriers and less social cohesion. If students have trouble using devices, they may feel anxious about using them and may become dependent on others. Communication support may be inconsistent when teachers are having difficulties with assistive listening systems. May lose instructions or peer response when technical problems arise. These barriers can lessen students' confidence and decrease peer interaction. This discovery echoes Rekkedal's (2017) observation that amplification systems can be used to facilitate academic participation, but not necessarily social participation, so there is a more nuanced social impact of technology than academic impact.

The values of significant correlation and significant regression are strong enough to indicate that there is statistically sound evidence that there is a relationship between better use of assistive technology and better social cohesion. This is a very high percentage of variance for educational research using survey instruments as it accounts for 64.8% of the variance in social cohesion due to the use of assistive technology. From this it can be concluded that assistive technology is a tool which is not only used for learning support, but also for social inclusion. This is, however, a strong predictive relationship and not an experimental one, as the study was cross-sectional.

The non-significant group differences for gender, class, home access, communication mode, and device type suggest that these variables alone may not determine social cohesion. Social cohesion appears to be shaped by broader classroom and school-level factors such as teacher support, peer attitudes, classroom practices, and communication access. The significant differences across age groups, hearing impairment levels, and years of assistive technology use indicate that social experiences vary according to developmental stage, severity of hearing impairment, and length of technology exposure. Students with longer experience using assistive technology may become more confident and independent, which may facilitate social participation. The reliability analysis showed weak internal consistency for several scales, which is a limitation of the study. This suggests that some items may not have measured the same construct consistently and may require revision, rewording, or regrouping into clearer subscales in future research.

Conclusion of the study

Based on the findings, it is concluded that assistive technology plays an important and significant role in supporting social cohesion among secondary school students with hearing impairment. Assistive technology usage was generally high across availability, teacher use, and student use, and students reported using various technologies in classroom and daily life contexts. Social cohesion among hearing-impaired students was generally positive, with students reporting high levels of peer interaction, belonging, participation, communication, acceptance, emotional connection, and classroom cohesion.

Other aspects of social cohesion that were relatively weaker were found to be: enjoying collaborative work, feeling accepted by classmates and feeling equal to other students, enjoying asking questions, perceived social support and trust. These weaker areas are associated with barriers to AT use such as difficulties operating devices, lack of training, teachers' difficulties, technical interruptions, unclear instructions, maintenance issues, signal or connectivity problems and limited classroom time.

Results of the inferential analysis were statistically significant and strongly correlated, with positive social cohesion related to the use of assistive technology. The results of regression analysis confirmed that the use of assistive technology was significantly related to social cohesion with variance. Social cohesion varied significantly among age groups, hearing impairment levels and years of AT use, but not among gender, class level, home access, communication mode or device type.

It is concluded that assistive technology is one of the most important factors that can predict social cohesion among hearing impaired students. The use of assistive technology, when available, functional and supported through training, technical support and inclusive classroom practices can greatly enhance students with hearing impairment's communication access, peer interaction, participation, inclusion and belongingness.

Recommendations of the study

Schools must provide access to assistive technology, make it available and fully functional and ensure it is part of the education environment and not just about the device. This should include; Cochlear implants, hearing aids, FM systems, captioning services, visual learning technologies, digital communication technologies, regular maintenance, technical support and follow-up services. Schools should also have regular maintenance plans and ensure adequate time set aside in lessons to set up and make full use of assistive technologies to minimise disruption and maximise learning opportunities.

Ongoing teacher professional development is an important part of working with AT. Teachers need to be able to maximize the benefits of AT. In the context of the classroom, teachers need to be prepared to use assistive technology in the following ways: for instruction; for group work; for discussions; for assessment; for presentations; for extra-curricular activities; and for peer interaction. In addition, teachers should watch hearing impaired children's involvement in class discussions and collaborative projects, and encourage and support children who may be reluctant to ask questions and participate in learning activities.

Assistive technologies should be integrated into the environment of the student and should be available to students for their own use with confidence and independence, linked to orientation and training programmes. Introducing new students to the school, supporting with clear and easy instructions on how to operate assistive devices, and ongoing training that will strengthen self-efficacy, confidence and self-directed technology use is essential. Some individual support should also be adjusted based on each student's age, level of hearing loss and length of time using assistive technology to meet the individual's educational and social needs.

In addition, schools should develop further the concept of social cohesion through the promotion of inclusive education by strengthening the concept of acceptance, trust, equality and meaningful relationships between hearing impaired students. There should be awareness programmes that decrease the stigma of hearing impairment and foster positive attitudes of fellow classmates. Peer-support programs should provide guidance to students to help their hearing-impaired peers in the collaborative learning and social environment, and schools should consistently implement captioned instructional materials, visual aids, and the use of multimedia to increase accessibility. In addition, parents need to be provided with information on the correct usage and maintenance of assistive devices at home and policy makers should provide sufficient funding and institutional support for the continuity of assistive technology programs in the secondary schools of hearing-impaired students.

Implications of the Study

The findings have several practical implications. At First, schools should treat assistive technology as a complete support system that includes devices, training, maintenance, classroom use, and follow-up support. Technical support services should be available to resolve device malfunctions, connectivity problems, and maintenance needs quickly. At Second, teachers require continuous professional training in the practical use of assistive technology for both instruction and peer

interaction. Training should include FM systems, cochlear implants, hearing aids, captioning, speech-to-text tools, digital sign language tools, and visual aids. Thirdly, students need clear, user-friendly instructions for operating assistive devices independently. Student training programs should improve confidence, self-efficacy, and independent use. Fourthly, schools should focus on weaker areas of social cohesion such as acceptance by classmates, social support, trust, confidence in asking questions, and feeling equal to other students. Awareness programs and peer-support initiatives can promote acceptance and reduce stigma. Finally, individualized support should consider students' age, hearing impairment level, and years of assistive technology use, as these variables showed significant differences in social cohesion.

The scales of assistive technology use and social cohesion should be further validated with factor analysis in future research. More samples in more provinces should be used for better generalizability. Effectiveness of AT use over time in relation to social cohesion should be studied using a longitudinal study design. Specific assistive technology interventions should be tested with experimental studies. Qualitative interviews with students, teachers, and parents will give greater depth to the statistical results by capturing students' and teachers' lived experiences that led to the results. Future studies can also investigate if there are differences in assistive technology utilization and social inclusion between different school types (special education versus inclusive schools).

Limitations

The study was conducted with secondary school students with hearing impairment in schools of selected area of Punjab; thus, the findings of the study should be generalized with caution. This study adopted a cross sectional survey design and thus, the experimental causality is not claimed. The reliability values for several measurements were low, indicating the need for further development of measurement instruments. The study did not involve qualitative interviews that might have given more explanation of the results.

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